

$\theta$	$\log q = \log \frac{z}{2} +$	$\theta$	$\log q = \log \frac{z}{2} +$
40 0	10.636	42 40	18.802
10	11.031	50	19.467
20	11.439	43 0	20.152
30	11.961	10	20.859
40	12.297	20	21.588
50	12.748	30	22.341
41 0	13.214	40	23.119
10	13.695	50	23.921
20	14.192	44 0	24.749
30	14.705	10	25.602
40	15.235	20	26.483
50	15.784	30	27.391
42 0	16.350	40	28.328
... 10	16.934	50	29.294
20	17.537	45 0	30.291
30	18.159		

*Reductions of Extra Meridian Observations of Planets.*

By P. H. Cowell.

*(Communicated by the Astronomer Royal.)*

The following method of reducing observations of planets with the altazimuth has been brought into use at the Royal Observatory, Greenwich.

From the observation of, let us suppose, the Moon, after correcting for instrumental errors and refraction, we have the data :

(1) At time  $t_1$  the Moon's limb was on the standard azimuth (*e.g.* prime vertical,  $45^\circ$  from meridian, &c.)

(2) At time  $t_2$  the Moon's limb was at zenith distance  $z$ , after allowing for refraction.

The method aims at transforming these data into the following :—

(1) At time  $T$  the Moon's centre was on the standard azimuth as seen from the Earth's centre.

(2) At the same time  $T$  the Moon's centre, as seen from the centre of the Earth, was at an inclination  $Z$  to the direction of gravity at Greenwich.

It is clear that when this transformation has been accomplished with argument  $Z$  we can obtain the Moon's geocentric polar distance and hour-angle ; and, combining the latter with  $T$ , the right ascension also.

The quantities to be calculated are  $T-t_1$  and  $Z-z$ ; the calculation of these quantities is equivalent to reducing the Moon to a star: that is to say, it corrects for the finite parallax and finite diameter.

The method is perfectly general, and is suitable for any azimuth. The computation has been assisted by forming tables for azimuths  $90^\circ$ ,  $80^\circ$ ,  $70^\circ$ ,  $60^\circ$ , and  $45^\circ$ , which are alone used at Greenwich. A special case is given below as illustration; the reasoning and the formulæ apply to any azimuth, the computing to the particular observation.

Description of Term.				Formula.	Numerical Value.
Approximate azimuth motion in one lunar second				$15 \sin \Delta \cos S$	...
Correction for motion in } R.A. ... .. }				$\frac{601.643 - 579.682 - \mu_s}{579.682}$	+0.00336
Correction for motion in } N.P.D. ... .. }				$-\frac{\sin c \sin A \operatorname{cosec} \Delta}{579.682}$	-0.001133
B ... ..				...	...
Semidiameter ... ..				+1L, -2L	...
Figure of Earth term ... ..				+0.003250 sin A	+0.003250
Curvature correction ... ..				$+\frac{15^2}{2 \times 206265} t^2 \cos \Delta \sin c \sin A$	...
A ... ..				...	...
$T-t_1$ ... ..				$\frac{A}{B} \times \frac{601.643}{579.682}$	...
$t_1$ ... ..				...	...
T ... ..				...	...
$t_2$ ... ..				...	...
$T-t_2$ ... ..				...	...
Approximate zenithal motion } in one sidereal second }				$+15 \sin c \sin A \frac{579.682}{601.643}$	...
Correction for motion in } R.A. ... .. }				$\frac{601.643 - 579.682 - \mu_s}{579.682}$	+0.00336
Correction for motion in } N.P.D. ... .. }				$\frac{\cos S}{601.643}$	+0.00125
B' ... ..				...	...
Motion in time $T-t_2$ ... ..				$B'(T-t_2)$	...
Semidiameter ... ..				+UL, -LL	...
Observed z.d., corrected for refraction				...	...
Approximate correction for parallax				$-pp \sin (\varepsilon + \zeta)$	...
Airy correction ... ..				...	...
Z ... ..				...	...

For planets other than Moon replace 579.682

1899 April 17<sup>d</sup> 11<sup>h</sup> 13<sup>m</sup>.3. Moon on Prime Vertical, West of Meridian.

<i>c</i>	colatitude	...	...	...	...	38° 31' 24''
<i>A</i>	azimuth reckoned from south towards west	+				90°
$\Delta$	north polar distance	...	...	...	=	71° 37' 35'
<i>S</i>	angle at planet subtended by line joining zenith to pole.					
$\mu_a$	motion in R.A. in 10 solar minutes	...	+			20 <sup>s</sup> .015
$\mu_\Delta$	motion in N.P.D. in 10 solar minutes	...	+			81'''.14
<i>p</i>	parallax	...	...	...	...	54' 16'''39

Precept.	Term.	Remarks.
...	10.7407	For other planets read "one sidereal second."
$\times 15 \sin \Delta \cos S$	+ 0.0361	...
$\times \mu_\Delta$	- 0.0919	...
sum	10.6849	
...	+ 888''.82	...
$\times p$	+ 10.58	Compression $\frac{1}{300}$ .
...	+ 0.74	$t = \frac{A}{B}$ .
sum	+ 900.14	...
...	+ 87.43 <sup>s</sup>	...
...	10 55 27.41	...
...	10 56 54.84	...
...	10 56 44.34	...
...	+ 10.50	...
...	+ 9.001	...
$\times 15 \sin c \sin A$	$\frac{579.682}{601.643}$	...
$\times \mu_\Delta$	+ 0.101	...
sum	+ 9.132	...
...	+ 1 35.89 <sup>o</sup>	...
...	- 14 48.82	...
...	+ 67 17 40.49	...
...	- 49 57.93	$\left\{ \begin{array}{l} \zeta = -11' 11'''.7 \cos A. \\ \log \rho = 9.999119. \end{array} \right.$
...	- 0.11	For Moon only.
sum	66 14 29.52	

by 601.643 and omit the Airy correction.

The method of the reduction is sufficiently explained by the first and second columns of the above specimen computation.

The numbers 601.643 and 579.682 that appear in the second column are the numbers of sidereal and lunar seconds respectively in 10 solar minutes.

The formulæ are easily proved ; an investigation of the Airy correction is given below.

For the figure of the Earth a compression  $\frac{1}{300}$  is used, and  $\rho$  is corrected for the height of the observatory above the sea-level.

The Airy correction is the excess of

$$-\sin^{-1} [\sin p(\rho \sin z + \mu)],$$

the true correction for parallax and semidiameter, over

$$-p\rho \sin z - \sin^{-1} (\mu \sin p),$$

which have been applied under the names of "approximate correction for parallax" and "semidiameter."  $\mu$  here denotes the ratio of the Moon's diameter to the Earth's equatorial diameter, and must be considered negative for the upper limb. Its numerical value is 0.273. The formula is easily reduced to the form

$$\frac{206265''}{6} \sin^3 p \sin z [0.78 - \sin z (\pm 0.82 + \sin z)]$$

for the lower and upper limbs respectively.

#### *On the Accuracy of Photographic Measures : Second Note.*

By H. C. Plummer, M.A.

1. Since the appearance of my first note on this subject (*Monthly Notices*, vol. lxi., p. 618), in which I took occasion to examine a recent memoir by M. Lœwy, the discussion has been shared by Mr. A. R. Hinks (*Monthly Notices*, vol. lxii., p. 132). More recently M. Lœwy has published two further memoirs of considerable length (*Conférence Astrographique Internationale, Circulaire No. 9*), in which he has developed his researches in a very elaborate manner. In what follows it will be convenient to denote M. Lœwy's first memoir (*Circulaire No. 8*) and the two later memoirs by  $L_1$ ,  $L_2$ , and  $L_3$  respectively, Mr. Hinks' paper by  $H_1$ , and my own by  $P_1$ . M. Lœwy's purpose, expressed shortly, has been to construct a formula which shall give a superior limit to the probable error of a coordinate determined photographically under any circumstances. If the validity of such a formula once determined be admitted, it will be possible to deduce from it, as M. Lœwy has done, a number of practical conclusions for guidance in the conduct of actual operations. On